B. Remarks/Arguments:

Introduction

Applicants thank the Examiner for the interview of April 15, 2003. The Examiner tentatively indicated, pending further review, the potentiality of allowable subject matter.

Claims 1-5 and 7-15 are pending. Claims 1, 4, 12 and 14 have been amended. The recitations of claim 7, which were directed to the molar constituents of the feed, have been incorporated into claims 1, 12 and 14. Accordingly, please cancel claim 7.

Claims 1, 12 and 14 have been further amended to describe the cooled feed as being a cooled and substantially condensed hydrocarbon feed stream. Support for this amendment may be found in paragraph [0025] of the Specification.

Claim 12 has been further amended to describe three cooling sources for cooling the feed in the cryogenic heat exchanger. The first cooling source is a condensed liquid hydrocarbon feed stream. Support for this amendment may be found in paragraph [0028] of the Specification. The second cooling source is the methane-rich stream from the de-methanizer column. Support for this amendment may be found in paragraph [0030]. The third cooling source is the compressed/cooled/turboexpanded methane rich stream. This third cooling source was originally claimed.

Section 112 Rejections

Claims 1-5 and 8-15 were rejected under 35 U.S.C. §112, first paragraph, as allegedly containing subject matter not adequately described in the Specification. The Examiner objected to the negative limitation in claims 1, 12 and 14 relating to lack of turboexpansion of the feed. The claims have been amended to remove the objected language.

Reconsideration and withdrawal of the rejection of claims 1-5 and 8-15 under 35 U.S.C. §112, first paragraph, are respectfully requested.

Section 103 Rejections

Claims 1-5 and 8-15 are rejected under U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,125,653 to Shu et al. ("Shu ") in view of either U.S. Patent No. 6,116,050 to Yao et al. ("Yao"); U.S. Patent No. 5,568,737 to Campbell et al. ("Campbell"); or U.S. Patent No. 5,890,377 to Foglietta ("Foglietta"). Applicants respectfully traverse.

The invention as presently defined by independent Claim 1 provides a process for recovering ethane from a hydrocarbon gas stream having methane, ethane and propane, the steps of which comprise:

providing the hydrocarbon gas stream comprising from about 50 % to about 75 % by mole methane, from about 15 % to about 40 % by mole ethane and from about 1 % to about 4 % by mole propane;

cooling the hydrocarbon gas stream by refrigeration to form a cooled and substantially condensed hydrocarbon feed stream;

separating the cooled and substantially condensed hydrocarbon feed stream into a methane-rich stream and an ethane/propane-rich stream, said methane-rich stream having a first pressure and a first temperature;

expanding said methane-rich stream from said first pressure to a second pressure to lower the temperature of said methane-rich stream from said first temperature to a second temperature to provide a cooling source for said refrigeration, wherein said second pressure is lower than said first pressure and further wherein said second temperature is lower than said first temperature;

separating said ethane/propane-rich stream into an ethane-rich stream and a propane-rich stream; and

recovering said ethane-rich stream.

The invention as presently defined by independent Claim 12 provides a process for recovering ethane from a hydrocarbon gas stream having methane, ethane and propane, the steps of which comprise:

providing the hydrocarbon gas stream comprising from about 50 % to about 75 % by mole methane, from about 15 % to about 40 % by mole ethane and from about 1 % to about 4 % by mole propane;

cooling the hydrocarbon gas stream to provide a vapor hydrocarbon feed stream and a condensed liquid hydrocarbon feed stream;

cooling the vapor hydrocarbon feed stream in a cryogenic heat exchanger by heat exchange with a first cooling source, a second cooling source and a third cooling source to form a cooled and substantially condensed hydrocarbon feed stream, wherein said first cooling is said condensed liquid hydrocarbon feed stream;

distilling the cooled and substantially condensed hydrocarbon feed stream and the condensed liquid hydrocarbon feed stream in a demethanizer column to form a methane-rich stream and an ethane/propane-rich stream, wherein methane-rich stream is said second cooling source;

compressing said methane-rich stream to form a compressed methane-rich stream;

cooling said compressed methane-rich stream to form a compressed methane-rich stream;

turboexpanding said compressed methane-rich stream to a lower pressure to provide a said third cooling source for said cryogenic heat exchanger;

distilling said ethane/propane-rich stream in a de-ethanizer column to form an ethane-rich stream and a propane-rich stream; and

recovering said ethane-rich stream.

The invention as presently defined by independent Claim 14 provides a process for recovering ethane from a hydrocarbon gas stream having methane, ethane and propane, the steps of which comprise:

providing the hydrocarbon gas stream comprising from about 50 % to about 75 % by mole methane, from about 15 % to about 40 % by mole ethane and from about 1 % to about 4 % by mole propane;

cooling the hydrocarbon gas stream by refrigeration to form a cooled and substantially condensed hydrocarbon feed stream;

separating the cooled and substantially condensed hydrocarbon feed stream into a methane-rich stream and an ethane/propane-rich stream, said methane-rich stream having a first pressure and a first temperature;

expanding said methane-rich stream from said first pressure to a second pressure to lower the temperature of said methane-rich stream from said first temperature to a second temperature to provide a cooling source for said refrigeration, wherein said second pressure is lower than said first pressure and further wherein said second temperature is lower than said first temperature;

recovering said methane-rich stream.

The gas feed 1 of Shu enters its process at ambient temperature (110°F) and high pressure (1800-2000 psig). (Shu, column 3, lines 27-29.) The gas feed 1 of Shu is first cooled in exchanger 102 and is then further cooled feed expander 104. Feed expander 104 is a turboexpander that reduces the gas pressure by a factor of 2 to 5 to induce auto-refrigeration to cool the gas to a required temperature of -89°F. (Shu, column 3, lines 27-36.) Such a cold temperature is necessary for the subsequent separation of methane from the other constituents of the gas feed 1 in the demethanizer column 108.

Such turboexpansion of Shu's gas feed is possible because, as discussed in the previous reply, Shu's feed is very lean, i.e., containing about 90 mole percent methane. Turboexpansion of Shu's feed under Shu's conditions results in a cooled feed stream that is about 14 mole percent liquid. A declaration by one of the inventor's, Filippo Pironti, is enclosed evidencing both the molar concentrations of Shu's feed and the relatively minor amount of liquid present after turboexpansion. Thus, Shu's hydrocarbon feed into its de-methanizer column is a substantially vapor hydrocarbon feed.

In contrast, the cooled feed stream of the present invention, as set forth in amended independent Claims 1, 12 an 14, is a cooled and substantially condensed hydrocarbon feed stream. Shu fails to teach or suggest such a cooled and substantially condensed hydrocarbon feed stream.

Moreover, as set forth in the enclosed Declaration, the hydrocarbon gas stream recited in amended independent Claims 1, 12 and 14 could not be processed by the teachings of Shu. If the much heavier gas streams of the present invention were attempted to be processed according to the teachings of Shu, then Shu's turboexpander would not provide adequate cooling to the feed stream. The heavier gaseous constituents would condense into liquid thereby utilizing much of the available enthalpy from turboexpansion for condensation of vapor hydrocarbon constituents into liquid hydrocarbon constituents, as contrasted to cooling of the overall hydrocarbon feed stream. As set forth in the enclosed Declaration, Shu could not obtain its required temperature of -89°F through turboexpansion when attempting to process the feed of the present invention as set forth in amended independent Claims 1, 12 and 14. Temperatures of only -16°F to -56°F could be achieved by Shu's turboexpansion of the feeds claimed by the present invention. Such hot temperatures, as compared to Shu's required temperature of -89°F, would make Shu's demethanizer inoperable because methane would not be adequately separated from the other gas constituents. In other words, the demethanizer overhead would contain excessive amounts of ethane and heavier constitutes making Shu's

subsequent processing of the demethanizer overhead inoperable for its intended purpose. Further details of Shu's inoperability with the feeds of the subject application are set forth in the enclosed declaration.

Furthermore, the use of turboexpanders on either a vapor stream or a liquid stream is well known to those of ordinary skill in the art. (See ROBERT H. PERRY ET AL., CHEMICAL ENGINEER'S HANDBOOK 24-30 to 24-45 (5th ed. 1973) (copy enclosed)) It is also well known to those of ordinary skill in the art that such turboexpanders are not capable for transforming a gaseous stream into a substantially liquid stream or a liquid stream into a substantially gaseous stream. (*Id.* at 24-35 and 24-44.) Even turboexpanders that are specifically designed to handle some condensation of a gaseous stream are limited to a maximum 20% liquid in their discharge. (*Id.* at 24-31) Thus, any attempt to modify the teachings of Shu to provide a cooled and substantially condensed hydrocarbon feed stream from turboexpansion would be contrary to the teachings of the general turboexpansion art and as such would impermissible.

Yao, Campbell and Foglietta, individually or in combination, fail to remedy the deficiencies of Shu. All of these references require turboexpansion of their gaseous feeds. (See Yao, Figures 2 and 5 showing turboexpander 31; Campbell, Figures 4-10 showing turboexpander 17; Foglietta, Figure 1 showing turboexpander 75.) As such, these references cannot provide the required cooling through turboexpansion for the feed streams as recited in the present application. Furthermore, these references cannot provide cooled and substantially condensed liquid hydrocarbon feed streams through their required turboexpansion schemes.

Thus, Shu, Yao, Campbell and Foglietta, individually or in combination, fail to teach the present invention as set forth in independent Claims 1, 12 and 14 because all the references use turboexpansion of the gaseous feed and such turboexpansion cannot form a cooled and substantially condensed hydrocarbon feed stream comprising from about 50% to about 75% by mole methane, from about 15% to about 40% by mole ethane and from about 1% to about 4%

by mole propane. Any attempt to modify the teachings of these references to arrive at the present invention would be impermissible because there is no teaching or suggestion in these references to cool the recited feeds of the subject application to cooled and substantially condensed liquid hydrocarbon streams. Furthermore, any such attempt would present inoperability concerns for all of these cited references, either from a process consideration, an equipment consideration or both. As such, these cited references teach away from the present invention because references that are modified and rendered inoperable for their intended purposes cannot be used to establish a *prima facie* case of obviousness. *In re Gordon et al.*, 221 U.S.P.Q. 1125, 1127 (CA FC 1984).

Still furthermore, Shu, Yao, Campbell and Foglietta, individually or in combination, fail to teach, *inter alia*, the cooling hydrocarbon gas feed streams in a cryogenic heat exchanger with the three cooling sources as recited in amended independent Claim 12. Any attempt to modify the teachings of these references to arrive at the present invention would be impermissible because there is not teaching or suggestion in these references to cool their feed with such recited cooling sources. (*Id.*)

Summary

Therefore, Applicants respectfully submit that independent claims 1, 12 and 14, and all claims dependent therefrom, are patentably distinct. This application is believed to be in condition for allowance. Favorable action thereon is therefore respectfully solicited.

Should the Examiner have any questions or comments concerning the above, the Examiner is respectfully invited to contact the undersigned attorney at the telephone number given below.

The Commissioner is hereby authorized to charge payment of any additional fees associated with this communication, or credit any overpayment, to Deposit Account No. 08-2461.

Respectfully submitted,

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